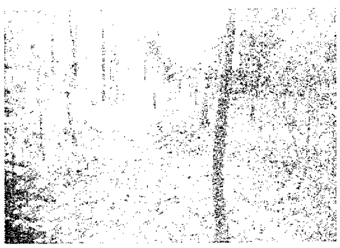
US Army Corps
of Engineers



ENVIRONMENTAL IMPACT
RESEARCH PROGRAM

TECHNICAL REPORT EL-95-25

POINT SAMPLING

Section 6.2.1, U.S. ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

by

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July 1995

Final Report

Prepared for DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000

Under EIRP Work Unit 32420

ENVIRONMENTAL LABORATORY

PREFACE

This work was sponsored by the Headquarters, U.S. Army Corps of Engineers (HQUSACE), as part of the Environmental Impact Research Program (EIRP), Work Unit 32420, entitled Development of U.S. Army Corps of Engineers Wildlife Resources Management Manual. Mr. Dave Mathis was the EIRP Coordinator at the Directorate of Research and Development, HQUSACE. The Program Monitors for the study were Dr. John Bushman, Mr. F. B. Juhle, and Mr. Forrester Einarsen, HQUSACE.

This report was prepared by Dr. Wilma A. Mitchell, Stewardship Branch (SB), Environmental Laboratory (EL), U.S. Army Engineer Waterways Experiment Station (WES), and Dr. H. Glenn Hughes, School of Forest Resources, Pennsylvania State University (DuBois campus), DuBois, PA. Dr. Hughes was assigned to EL under an Intergovernmental Personnel Act agreement during the development of this report. Mr. Chester O. Martin, SB, was principal investigator for the work unit. WES review was provided by Mr. Martin, Mr. John Tingle, and Mr. Darrell Evans, SB.

The report was prepared under the general supervision of Mr. Hollis H. Allen, Acting Chief, SB, EL; Dr. Robert M. Engler, Chief, Natural Resources Division, EL; and Dr. John W. Keeley, Director, EL. Dr. Russell F. Theriot, WES, was the EIRP Program Manager.

At the time of publication of this report, Dr. Robert W. Whalin was Director of WES. COL Bruce K. Howard, EN, was Commander.

This report should be cited as follows:

Mitchell, Wilma A., and H. Glenn Hughes. 1995. "Point sampling: Section 6.2.1, U.S. Army Corps of Engineers Wildlife Resources Management Manual," Technical Report EL-95-25, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

NOTE TO READER

This report is designated as Section 6.2.1 in Chapter 6 -- CENSUS AND SAMPLING TECHNIQUES, Part 6.2 -- VEGETATION SAMPLING TECHNIQUES, of the U.S. ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a separate Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 6.

POINT SAMPLING

Section 6.2.1, U.S. ARMY CORPS OF ENGINEERS

WILDLIFE RESOURCES MANAGEMENT MANUAL

Point sampling techniques are most frequently used to collect vegetative data for the estimation of ground cover over an area. Commonly measured variables are canopy cover of herbaceous vegetation, shrubs, and trees; basal cover of herbs; and bare ground. Point sampling has also been used to determine frequency and biomass without destroying the vegetation (Hughes 1962, Jonasson 1983, Bonham 1989).

Point sampling techniques are useful whenever time and manpower are major considerations, as large amounts of reliable data can be collected rapidly with minimal equipment and personnel. A major use of point sampling is collection of data for habitat evaluation and management, as vegetative cover is essential for the determination of habitat quality for many wildlife species. Cover is the most frequently measured variable in the Habitat Suitability Index models that are used in Habitat Evaluation Procedures.

ASSUMPTIONS

In plot sampling, the sample areas (quadrats) vary in size from very small units such as square inches or centimeters to portions of acres or hectares. Point sampling is based on the assumption that a point represents the ultimate reduction in quadrat size to a dimensionless point (Pieper 1978). Therefore, a pin point with virtually no area can be used to obtain the same information as that provided by a quadrat. If a narrow rod or pin is passed vertically through the vegetation, the plants it touches are those located vertically over a single point of ground; recording these contacts at a large number of points can provide reliable information about the composition of vegetation in a given habitat type (Goodall 1952).

The proportion of points intercepting vegetation out of the total number of points sampled is a statistically unbiased estimate of the cover over an area (Raelson and McKee 1982). Since point quadrats are small enough to detect small bare areas, this estimate corresponds to the strict definition of cover that accounts for small openings within canopies.

BACKGROUND

Point Quadrat Method

Point sampling is a modification of the point quadrat method, which originated in 1925 to evaluate range vegetation in New Zealand (Goodall 1952). Point quadrat utilized a frame containing a row of 10 steel pins that established 10 sample points at each sampling station (Levy and Madden 1933). Stations were randomly located, and all vegetation touched by each pin as it was projected downward was recorded as "hits" (a hit = 1 item of data).

The frame used by Levy and Madden (1933) was made of horizontal brass bars that held the pins vertically. However, other point frames have been used to fit individual project sampling needs. Examples are 10-pin inclined frames (Rader and Ratliff 1962, Sharrow and Tober 1979), a 100-point frame (Taha et al. 1983), circular frames (Morris 1973, Baker and Thomas 1983), a vertical magnetic frame (Neal et al. 1969), and rectangular frames with 2 sets of cross hairs that form from 25 points (Stanton 1960) to 36 points (Floyd and Anderson 1982). The point quadrat technique is also called point frame, point intercept, or point frequency. An illustration of a 10-pin inclined point quadrat frame is shown in Figure 1.

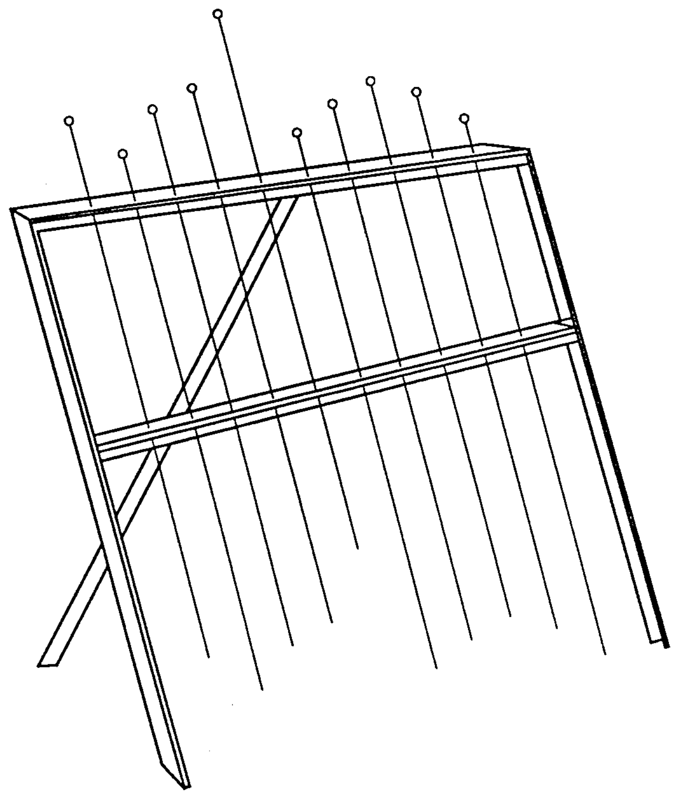


Figure 1. Point quadrat frame with inclined pins

Single Point Sampling

Eden and Bond (1945) reduced the number of sampling points to a single point for collecting herbaceous vegetation. Various forms of single point sampling have been used for vegetation analysis, including step point, in which the point is defined with the tip of the observer's boot (Goodall 1952, Evans and Love 1957, Nerney 1960, Owensby 1973, Mentis 1981, Strauss and Neal 1983), and wheel point, in which the point is determined by an indicator on a wheel pushed by the observer (Tidmarsh and Havenga 1955, Von Broembsen 1965, Mentis 1981, Griffin 1989). Both point quadrat and single point sampling are currently employed in ecological field surveys.

The techniques described in this report are based on the previously established point techniques. Step point was modified from the technique used by Evans and Love (1957), in which the point was determined by a single pin placed in a notch on the toe of the observer's boot. In the step point method described here, the pin has been eliminated and only a thin mark or sharp notch on the boot tip defines the sample point. The point frame technique utilizes a single pinpoint opening or cross hair intersection to establish the sample point, which is considered to extend from the ground perpendicularly through the tree

canopy. An ocular tube is used to sample tree canopy cover at the same point at which shrub and herbaceous cover is sampled on the ground. In both methods, sampling is conducted by one observer, who locates sample points at predetermined intervals along a transect and records the presence or absence of herbaceous, shrub, and tree canopy cover at each point. Unless otherwise indicated, further mention of point sampling refers to the single-point methods described in this report.

TECHNIQUE SELECTION

Major reasons for selecting point sampling techniques are efficiency, objectivity, and application to a wide range of habitats. These attributes are discussed below in more detail.

Efficiency

Time. Point sampling is an efficient method to use for large-scale surveys, as many data points can be collected per unit time (Hays et al. 1981). Evans and Love (1957) found that step point required only 1/6 to 1/8 as much time as the point quadrat method to obtain comparable data and that an experienced technician could sample 100 points per acre in 30 minutes on western ranges. Using a single point requires only 1/3 as many data points as using groups of pins (point quadrat) for comparable accuracy (Greig-Smith 1964). The single-point frame requires more time than step point but much less time than point quadrat. A day's time may be needed to develop proficiency using point sampling techniques; however, data collection proceeds rapidly once a technique is learned.

Equipment. The equipment used in point sampling is minimal. Step point requires only the observer's boot; point frame equipment is lightweight and easy to transport. The L-shaped frame is more maneuverable in dense understory than the four-legged frame and rigid quadrats. Overstory cover can be sampled at the same point at which the other cover categories are sampled.

Personnel. Point sampling can be applied by one person, and proficiency can be attained in a short period of time. These techniques are especially useful for sampling extensive areas when manpower is limited.

Objectivity

Point sampling provides essentially unbiased data. It is more objective than methods based on visual estimation, because "presence" or "absence" is the only data recorded. Greater accuracy can be expected because only 1 item of data

is collected for each cover category at each sampling station. Points can be readily replicated to provide the desired precision for a study.

Point sampling techniques control over- and underestimation of vegetative cover because data are collected only for vegetation detected by a minute marker (point or thin line). Grasses are frequently overestimated, and forbs are underestimated with a pin frame when contacts with the pin sides are counted (McLean and Cook 1968). To avoid this bias, Wilson (1959, 1963) constructed an apparatus with a very sharp pin and recorded only the vegetation that contacted the point (not the sides) of the pin. The point frame method described in this report is essentially like the sharp pin; a minute area is used to define sample points and thus reduce bias resulting from point thickness and pin sides.

A disadvantage of point sampling is that points cannot be accurately relocated. If repeated sampling is required to estimate changes in cover, a plot method (e.g., Daubenmire) may be employed more effectively. However, repeated sampling of permanent transects should produce results comparable to those obtained by repeated sampling of exact points.

Application

Point sampling can be used to estimate cover in a wide variety of vegetation types. The most reliable results are obtained in open and semi-open habitats, such as grasslands, shrublands, old fields, savannas, and open forests. Step point has been applied extensively to grasslands (Evans and Love 1957, Mentis 1981, Strauss and Neal 1983) but works well in savannas and open forests, especially on even terrain (Hays et al. 1981). Low light intensity may render point frame less efficient than step point in dense forests. Neither technique is recommended for use in wet habitats, where results may be biased by problems with the soft substrate.

Data can be collected more rapidly with step point than with point frame but data are generally less accurate. Step point is particularly well suited to studies in which cover is broadly defined (i.e., small canopy gaps in trees and shrubs are excluded from sampling), but it is ill-suited for trees and shrubs if cover is narrowly defined (i.e., small canopy gaps are included in sampling).

Studies conducted by the authors comparing these two variations of point sampling across a wide range of sites and vegetation types revealed, as expected, that step point overestimated tree and shrub canopy cover. This was primarily because cover was broadly defined in the step point technique and narrowly defined in the point frame technique. With step-point, the overestimation of

tree cover ranged from 9 to 22%, with an average of 15%; the overestimation of shrub cover ranged from -1 to 27%, with an average of 9.5%. For both trees and shrubs, strong positive correlations were found between point frame and step point results, thereby allowing the use of simple conversion equations to estimate point information from step point data.

The specific point sampling technique selected will be determined by study objectives and will depend upon the definition of cover adhered to in the study. Point frame is the most accurate and precise but requires more time. Step point, as described in this study, can be reliably applied in grasslands and habitats composed chiefly of herbaceous vegetation. Although there are few published reports on using step point for shrubs and trees, our analyses showed that simple equations can be made to convert step point to point frame data. If a high degree of accuracy is not tantamount to management objectives, the efficiency of step point may still justify its use when time and manpower are limited.

STUDY DESIGN

The study design presented below is not unique to point sampling but is a general design that may be used with other vegetation sampling techniques. It is a combination of random and systematic sampling and may be altered to fit project needs.

Site Selection

Aerial photographs should be studied and a ground reconnaissance should be conducted to determine the size and characteristics (e.g., terrain, heterogeneity) of the study area. The sites to be sampled should be selected and located on a map of the study area prior to data collection. If the area is large and homogeneous, sites may be randomly selected by using a numbered grid and random number selection. However, if the study area consists of diverse habitats, it may be preferable to select sites representative of the vegetation types in proportion to the amount of area occupied by each.

Transects

Although points may be randomly located across a site, it is logistically easier to establish randomly located transects and to sample at regular intervals along each transect. The random location of transects meets the statistical assumption of sampling unit independence, and systematic sampling along each transect facilitates rapid sampling. Transects selected for sampling should be indicated on the site map. Transects may be of predetermined or indefinite

length, and sample points may be continuous or located at stations equally spaced along the transects. If statistical tests are not needed, it may be appropriate to use a grid design in which sampling units are evenly distributed over the entire area (Goodall 1952, Evans and Love 1957).

Sampling Design

At each site, data are collected at 20 stations located at constant intervals along the transects. The distance between stations will be determined by the size of the study area and should be great enough to distribute points over the area. At each station, 10 points of data are collected at 2-m intervals (approximately a man's pace length) along the transect. If other data are being collected on the transect, the points may be located on a line parallel to the main transect and 1 pace to the right or left of it. This procedure may be used with any single-point sampling design.

Sample Size

Sample size is extremely important in habitat studies and should be determined by specific research objectives and the types of habitat sampled. The number of sampling points should be based on the approximate acreage to be included in the study area; at least 10 (preferably 20) samples per unit should be taken (Severinghaus 1980). Evans and Love (1957) used 100 points per acre for sampling rangeland vegetation with the step-point method. Severinghaus (1980) suggested the following guide for determining the number of sample points:

0 to 40 acres (0 to 16 ha) = 1 point/acre (0.5 ha)

41 to 80 acres (16 to 32 ha) = 1 point/2 acres (1 ha)

81 to 200 acres (32 to 80 ha) = 1 point/4 acres (1.6 ha)

>200 acres (80 ha) = 1 point/10 acres (4 ha)

Sample size can be calculated if data are separated by points. A formula commonly used to calculate sample size (Snedecor 1950) is

$$N = \frac{s^2 t^2}{d^2}$$

where

N = number of sample points required

s = standard deviation

t = t-value with n-1 degrees of freedom

d = allowable error (i.e., arithmetic mean of the sample total times the designated percent accuracy)

If a study encompasses many vegetation types, sample size should be determined for each type (e.g., old field, shrub steppe, or evergreen forest) rather than for the total acreage of the study area. Sample size may be modified by increasing or decreasing the number of sites or the number of samples collected at each site. The latter may be achieved by altering the number or length of transects or by changing the number of points sampled at each station.

PREPARATION

Users should be proficient with point sampling <u>before</u> data collection begins because results may be biased if the technique is learned during the study. The observer should use a compass to pace straight transect lines and practice consistent pacing between points. Consistent pacing is essential for preventing over- or underestimation of vegetative cover (Hays et al. 1981). It ensures that intervals between stations and among sample points are consistent throughout the study, thus providing reliable data for statistical analysis.

The sampling procedure should be practiced so users can gain confidence with the technique before actual data collection begins. It is recommended that field personnel gain experience with point sampling by conducting trial runs in the type(s) of vegetation that will be sampled in the study. Practice sites should be randomly located in a variety of vegetation types to familiarize personnel with using the technique in diverse habitat conditions.

SAMPLING PROCEDURES

<u>Cover Categories</u>

Three categories of vegetative cover are herbaceous vegetation, shrubs, and trees. These categories are defined as follows:

1. Herbaceous vegetation: Grasses, grasslike plants such as sedges and rushes, and forbs (broad-leaved flowering plants).

2. Shrubs: Woody plants, branched at or near the base and usually less than 15 ft (4.6 m) in height (Preston 1961); woody vines may be classed as shrubs or placed in a separate category.

3. Trees: Woody plants with a main stem (trunk), numerous branches, and a height of 20 ft (6.1 m) or more (Petrides 1972). A tree may be placed in the shrub category if it is less than 20 ft tall. Criteria for trees and shrubs will be determined by study objectives.

Step Point

Equipment. The only equipment needed is the observer's boot with an indicator to define the sampling point. The tip of one boot should be marked with a small V-shaped notch or narrow permanent line (Fig. 2). The marker is placed at the boot tip to provide a consistent sampling point and to minimize disturbance to the vegetation before sampling. The notch or line should be as narrow as possible to avoid overestimation of cover.

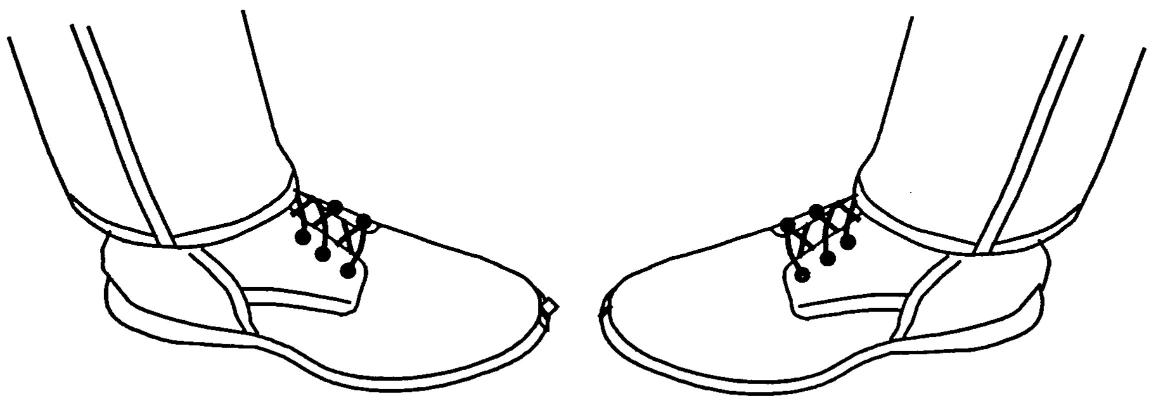


Figure 2. A narrow line or V-shaped notch at the tip of the boot indicates the sample point

Data collection. The procedure for collecting data at each point on the transect is given below.

1. Pace to the sample point.

2. Examine the vegetation at the tip of your boot.

3. Record the presence (hit) or absence (miss) of each cover category, with 1 = "hit" and 0 = "miss" (see DATA RECORDING). If sampling is conducted in nonforested vegetation types, data will be collected for only the first two categories.

   a. Herbaceous vegetation: Record a hit if the mark or notch on your boot tip is touching a grass or forb (Fig. 3). If it is not touching herbaceous vegetation, record a miss (Fig. 4). (If the herbaceous vegetation is growing under a shrub canopy, move aside the shrub limbs and foliage to sample the herbs.)

   b. Shrub: Record a hit if the marker on your boot is touching a shrub or is under its canopy (Fig. 5). If not, record a miss.

   c. Tree: Look directly overhead. Record a hit if you are under the canopy of a tree; if not, record a miss.

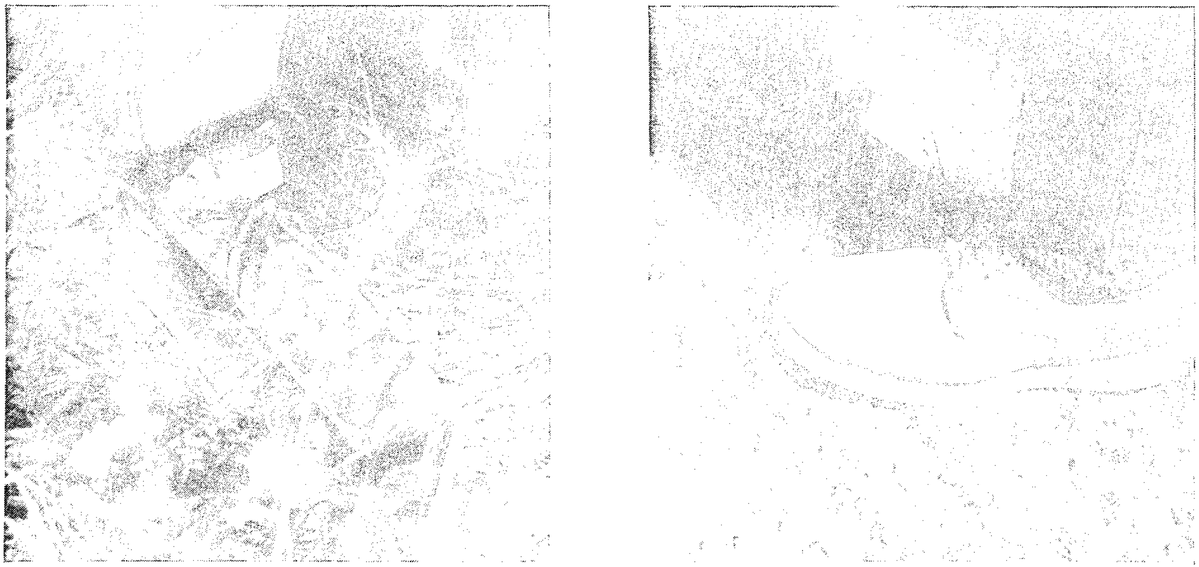


Figure 3. The marker on the boot tip is touching herbaceous vegetation

Figure 4. The marker on the boot tip is near but not touching herbaceous vegetation

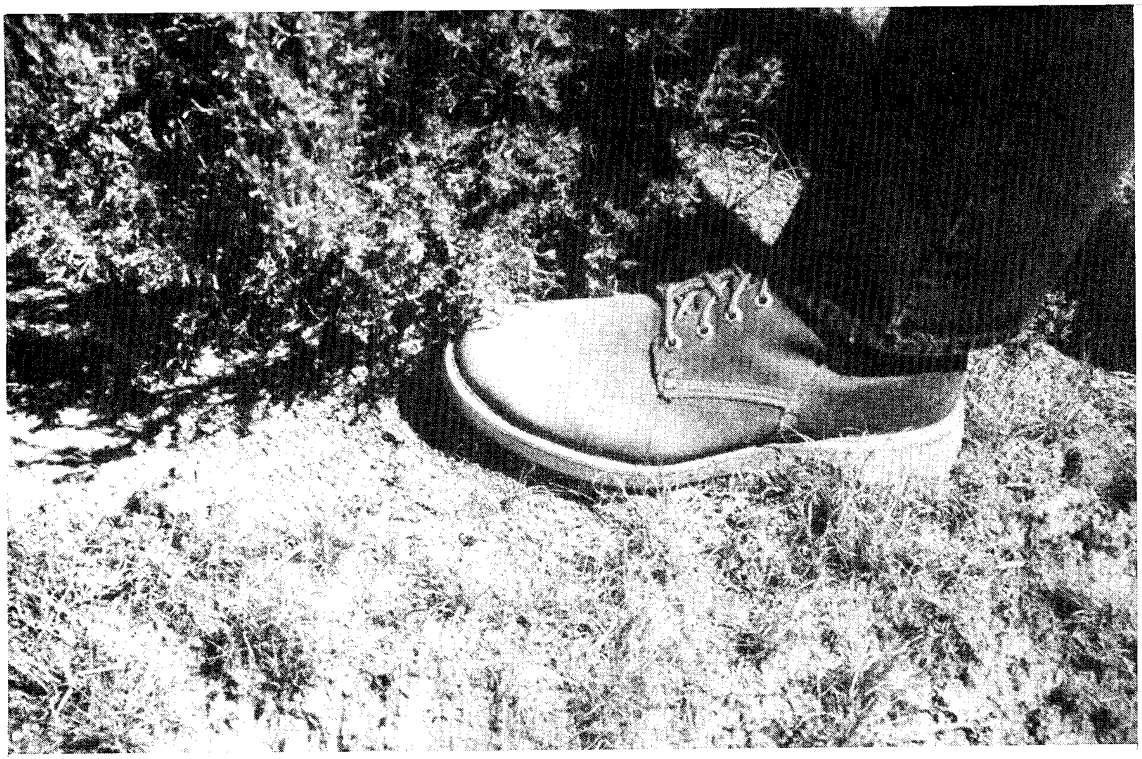


Figure 5. The marker on the boot is touching a shrub and is also under its canopy

4. Move to the next sampling point and repeat the above procedure.

An outline of this procedure without illustrations is provided in Appendix A. The single instruction sheet is convenient to carry into the field after the technique has been essentially learned.

Point Frame

Equipment. Two pieces of equipment are used for establishing points. An L-shaped wooden frame that supports a rod level and sighting tube is used to locate points in herbaceous and shrub cover (Fig. 6a). The sighting tube is a 35-mm film canister with a pinpoint opening in the bottom. An overstory sighting tube is used to establish points in tree canopy (Fig. 6b). It is made of polyvinyl chloride (PVC) pipe with very thin cross hairs (guitar string) that define the sample point. The point frame and overstory sighting tube are easily constructed from inexpensive materials available from local sources. Directions for the construction of equipment are provided in Appendix B.

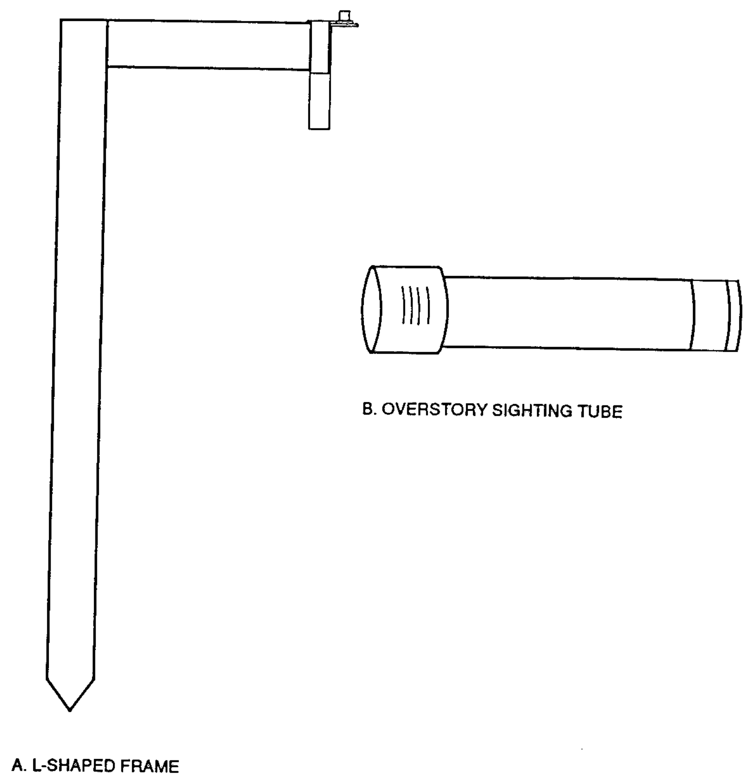


Figure 6. Equipment used for the point frame technique

Data collection. The procedure for collecting data at each point on the transect is given below.

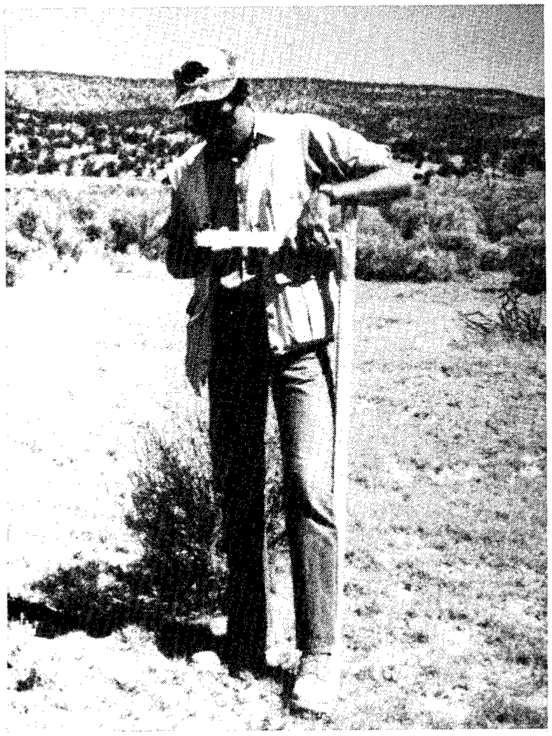
1. Pace to the sample point. Use the point frame to collect data for herbaceous vegetation and shrubs. Place the vertical piece of the frame against the tip of your boot and point the horizontal piece forward along the direction of travel. Once the frame is in place, reposition yourself closer to the rod level and sighting tube (Fig. 7a). You should be able to look straight down into the tube without moving the frame (Fig. 7b).

2. Leaning over, use the rod level to align the sighting tube vertically (perpendicular to the horizontal plane). The frame is level when the bubble is centered in the ring (Fig. 8).

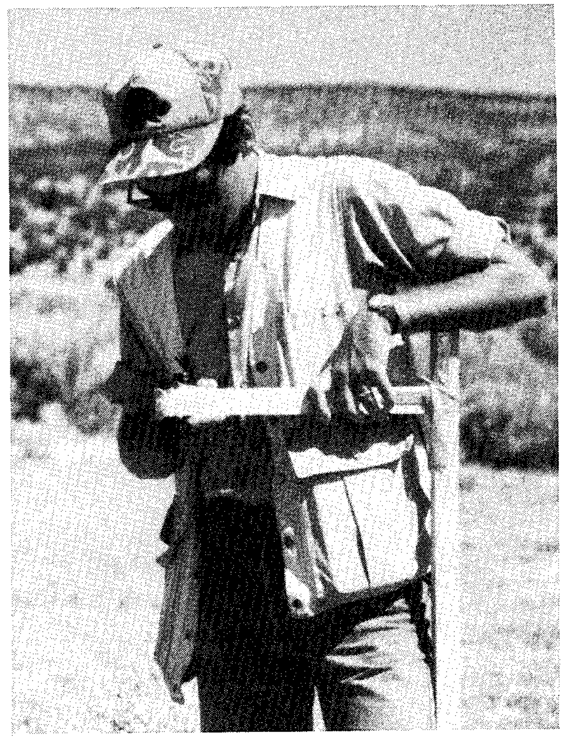
3. Align yourself directly above the sighting tube, keeping the pin-point opening in the center of the tube (Fig. 9).

4. Check the rod level to be sure the tube is level.

5. Look straight down into the opening of the sighting tube to determine the presence or absence of ground cover components in the center of the opening.



a



b

Figure 7. The observer has placed the frame at the sample point and (a) repositioned himself nearer the sighting tube; (b) he can look straight down into the tube without moving the frame

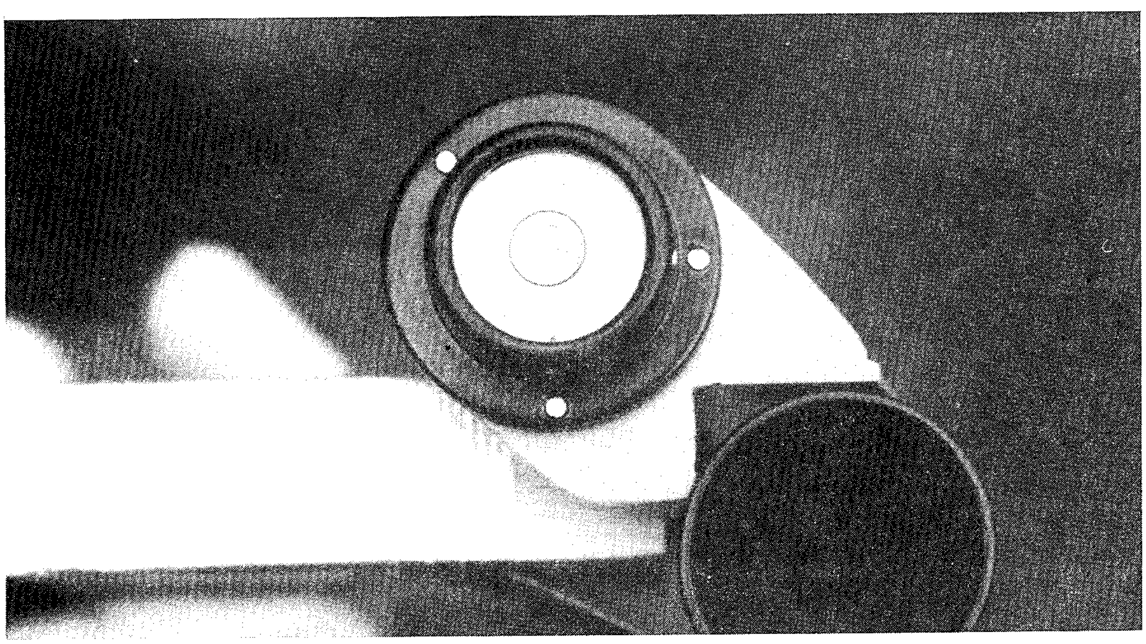


Figure 8. The frame is level when the bubble is in the center of the ring

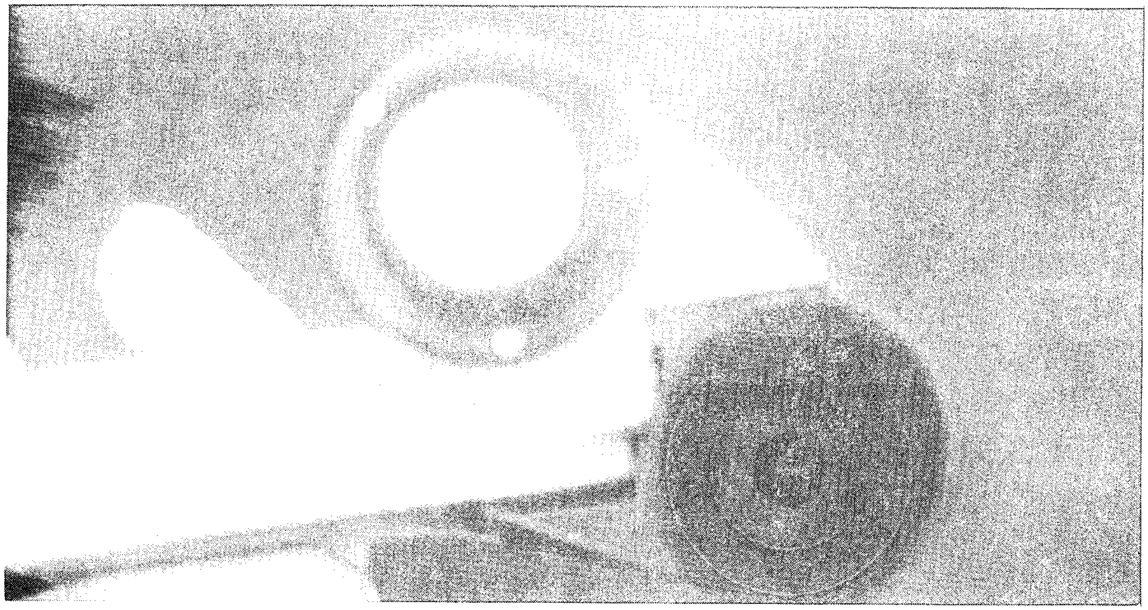


Figure 9. The opening in the bottom of the canister should be in the center of the tube

6. Record the presence (hit) or absence (miss) of both herbaceous vegetation and shrubs, with 1 = hit and 0 = miss (see DATA RECORDING).

   a. Herbaceous vegetation: Record a hit if a grass or forb appears in the opening of the sighting tube. If not, record a miss. (If the herbaceous vegetation is growing under a shrub canopy, move the shrub limbs and foliage aside to sample the herbaceous cover.)

   b. Shrub: Record a hit if a shrub species appears in the opening of the sighting tube. If not, record a miss.

7. Use the overstory sighting tube to sample tree canopy cover. Stand at the point where herbaceous vegetation and shrubs were sampled and look directly overhead. Place the sighting tube to one eye, and hold it perpendicular to the horizontal plane (i.e., vertically, not at an angle). Look at the point where the wires cross. (Be sure that the cross hairs are at the end of the tube <u>farthest from your eye</u>.)

8. Record a hit if there is canopy cover at the cross hairs; record a miss if there is none. (Canopy includes both foliage and limbs.)

9. Move to the next sampling point and repeat this procedure.

An outline of the procedure without illustrations is provided in Appendix A. The single instruction sheet is convenient to carry into the field as a reminder after the technique has been essentially learned.

DATA RECORDING

A blank data sheet is provided in Appendix C. Point data from each sampling site can be recorded and calculations can be performed on the same data sheet. The cover data for each point should be placed under the appropriate point number. Hit/miss tabulations should be recorded diagonally for each sample point, with herbaceous at the top, shrub in the middle, and tree at the bottom. If more than one data sheet is needed, it may be convenient to total the numbers on each sheet and do the final calculations on the last sheet.

Example. A sample data sheet containing actual field data from a point frame application is provided to illustrate data recording and analysis (Fig. 10). The data from Station 1, Point 1, show a hit ("1") for herbaceous, a miss ("0") for shrub, and a hit ("1") for tree. The data at Station 2, Point 1, indicate a miss for herbaceous, a hit for shrub, and a hit for tree.

DATA ANALYSIS

Data analysis consists of determining the average percentage herbaceous, shrub, tree, and total cover at a site. This is done by dividing the total number of hits for each cover category or the site by the total number of points sampled and converting the result to percentage.

The calculations for data analysis are given in a stepwise outline and illustrated with actual data.

1. Add the number of hits ("1's") for each cover category (herbaceous, shrub, trees) at each sampling station and enter these values in the summation columns ($\sum$H, $\sum$S, $\sum$T) under HITS/STATION.

2. Find the total cover at each station by adding the number of points for which at least one hit was recorded. Enter these values in the last summation column ($\sum$ POINTS with HITS).

3. Add the data in each summation column to find the total number of hits in each cover category and the total number of points with cover at each site. Enter the totals at the bottom of the data sheet.

4. Find the total number of points sampled at each site by multiplying the number of points per station by the total number of stations.

   Total points = Number of points per station × number of stations

POINT SAMPLING

AGENCY/OWNER: USFS PROPERTY: Allegheny Nat'l Forest DATE: 19 July 90

OBSERVER: Hughes COUNTY: Warren ACREAGE: 34 STAND NO. 16

VEGETATION TYPE: Allegheny Hardwood COMPARTMENT/UNIT: 38 PAGE 1 of 1

Station	Point Number 1	2	3	4	5	6	7	8	9	10	Hits/Station ΣH	ΣS	ΣT	Σ Points w/Hits
1	1 0 1	1 0 1	1 0 1	1 0 1	1 0 1	0 0 0	1 0 1	0 0 1	0 1 1	0 1 1	6	2	9	9
2	0 1 1	0 0 1	1 0 1	1 0 1	1 0 1	0 1 1	1 1 1	1 0 1	0 1 1	1 0 1	6	4	10	10
3	0 0 1	1 0 1	1 0 0	1 0 1	0 0 1	0 1 1	1 0 1	1 0 1	1 1 1	1 0 1	7	2	9	10
4	0 0 1	1 0 0	1 1 0	1 0 0	0 1 0	0 0 1	0 0 1	1 0 1	1 0 0	1 0 1	6	2	5	10
5	1 0 1	0 0 1	1 0 1	0 0 1	1 0 1	1 0 1	1 0 1	1 0 1	1 0 1	1 0 0	8	0	9	10
6	0 0 1	0 0 1	1 0 1	0 0 1	0 0 1	0 0 1	0 0 0	0 0 1	0 1 1	0 0 1	1	1	9	9
7	0 0 1	0 1 0	1 0 1	0 0 1	0 1 1	0 0 1	0 0 1	0 1 1	0 1 1	0 0 1	1	4	9	10
8	0 0 1	0 0 1	0 0 1	0 1 1	0 0 1	0 1 1	1 0 1	0 0 1	1 1 0	0 0 1	2	3	9	10
9	0 0 1	0 1 1	1 0 1	0 1 1	0 0 1	0 0 1	0 0 1	0 1 1	0 0 1	0 1 1	1	4	10	10
10	0 1 1	0 1 1	0 0 1	0 1 1	0 0 1	0 1 1	0 0 1	1 0 1	0 0 1	1 1 1	2	5	10	10
11	0 0 1	0 1 1	0 0 1	0 1 1	0 0 1	1 0 1	1 1 1	1 0 0	0 1 1	0 1 0	3	5	8	10
12	1 0 1	0 0 1	1 0 0	0 0 1	1 0 1	0 1 1	0 0 0	1 1 1	0 1 1	0 0 1	4	3	8	9
13	0 0 1	0 1 1	1 1 1	1 0 1	0 0 0	1 0 1	0 1 1	1 0 1	0 0 1	0 0 1	4	3	9	9
14	0 0 1	0 0 1	0 0 1	0 1 1	0 0 1	1 1 1	1 0 1	0 0 1	1 0 0	1 0 1	4	2	9	10
15	1 0 1	1 0 1	0 0 1	1 0 1	1 0 1	0 0 1	0 1 1	0 0 1	1 0 1	1 0 1	6	1	10	10
16	0 0 1	0 0 1	0 0 1	0 0 1	0 0 1	0 1 1	0 0 1	0 0 0	1 0 1	1 0 0	2	1	8	9
17	1 0 1	1 1 1	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 1	1 0 1	1 0 1	10	1	5	10
18	1 1 1	1 0 1	0 0 1	0 1 1	0 1 1	0 0 1	0 0 1	0 1 1	0 0 1	0 1 1	2	5	10	10
19	0 0 0	0 0 1	0 0 1	0 0 1	1 0 1	1 0 1	1 0 1	1 0 0	0 0 1	1 0 1	5	0	8	9
20	0 1 1	0 1 1	0 1 0	0 1 1	1 0 1	0 1 1	1 0 1	1 0 1	1 0 1	1 0 0	5	5	8	10
							Total Hits				85	53	172	194
							% Cover				42.5	26.5	86	
							Total % Cover							97

$$\bar{x}\ \%\ \text{Cover} = \frac{\text{Total No. Hits}}{\text{Total Points Sampled}} \times 100$$

Figure 10. Sample data sheet used to illustrate data recording and analysis using the point frame technique

5. Calculate the average percent cover for each cover category by dividing the total number of hits for the category by the total number of points sampled and multiplying by 100.

$$\bar{x}\ \%\ \text{Cover} = \frac{\text{Total number of hits}}{\text{Total number of points sampled}} \times 100$$

6. Calculate the average percent total cover for the site by dividing the total number of points with hits by the total number of points sampled and multiplying by 100.

$$\bar{x}\ \%\ \text{Total Cover} = \frac{\text{Total number of points with hits}}{\text{Total number of points sampled}} \times 100$$

Example. Data from the sample data sheet (Fig. 10) are used to illustrate the calculations outlined above.

(1) Total number of hits at Station 1 for each cover category:

herbaceous = 6; shrub = 2; tree = 9.

(2) Total number of points with hits at station 1 = 9.

(3) Total number of hits for each cover category:

herbaceous = 85; shrub = 53; tree = 172.

Total number of points with at least 1 hit = 194.

(4) Twenty stations were sampled at this site; therefore, the total number of points sampled:

10 points per station × 20 stations = 200 points

(5) Average percent cover for each cover category:

Herbaceous: $\bar{x}\ \%\ \text{Cover} = \frac{85}{200} \times 100 = 42.5\%$

Shrub: $\bar{x}\ \%\ \text{Cover} = \frac{53}{200} \times 100 = 26.5\%$

Tree: $\bar{x}\ \%\ \text{Cover} = \frac{172}{200} \times 100 = 86.0\%$

(6) Average percent total cover for the site:

$$\bar{x}\ \%\ \text{Total Cover} = \frac{194}{200} \times 100 = 97.0\%$$

CAUTIONS AND LIMITATIONS

To prevent error resulting from over- or underestimation of cover, attention should be given to detail. Equipment should be checked frequently to

maintain its integrity. The horizontal arm of the frame should remain tightly connected to the vertical piece to prevent it from dropping and forming less than a right angle. The cross hairs of the overstory sighting tube should remain tight so the cross point will always be at the center of the tube. The mark on the boot used in step point may fade with exposure to moisture and need to be repenned. This narrow mark should be maintained at exactly the same width throughout the data collection.

Pace length tends to increase with more rapid movement and to shorten as pace slows. Therefore, it may be difficult to maintain consistent pacing over uneven terrain or in vegetation with a high brush component. The observer should check his pace length in such habitat types and readjust it to the standard distances used in the study design.

A source of error with the point frame technique can result from not holding the equipment level (perpendicular to the horizontal plane). Each sample point is considered to extend from the ground upwards through shrub and tree canopy; therefore, it is essential to keep the horizontal arm of the frame level during sampling. For the same reason, the overstory sighting tube must be held vertically. Otherwise, cover estimates at a sample point may be biased.

For best results, point sampling should be suspended when light intensity becomes too low for accurate determination of cover.

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APPENDIX A

PROCEDURES FOR DATA COLLECTION

STEP-POINT: PROCEDURE FOR DATA COLLECTION

1. Pace to the sample point.

2. Look at the vegetation at the tip of your boot.

3. Record the presence (hit) or absence (miss) of each cover category, with 1 = "hit" and 0 = "miss."

   a. Herbaceous vegetation: Record a hit if the mark or notch on your boot tip is on or touching a grass or forb. If it is not touching herbaceous vegetation, record a miss. (If the herbaceous vegetation is growing under a shrub canopy, move aside the shrub limbs and foliage to sample the herbaceous cover.)

   b. Shrub: Record a hit if the tip of your boot is touching a shrub or is <u>under</u> its canopy. If not, record a miss.

   c. Tree: Look directly overhead. Record a hit if you are under the canopy of a tree. If not, record a miss.

4. Move to the next sample point and repeat the above procedure.

POINT FRAME: PROCEDURE FOR DATA COLLECTION

1. Pace to the sample point. Use the point frame to collect data for herbaceous vegetation and shrubs. Place the vertical piece of the frame against the tip of your boot, and point the horizontal piece forward along the line of travel. Once the frame is in place, reposition yourself closer to the rod level and sighting tube.

2. Lean over and use the rod level to align the sighting tube vertically. The frame is level when the bubble is in the center of the ring.

3. Align yourself directly above the sighting tube, keeping the pinpoint (lower) opening in the center of the tube.

4. Check the rod level to be sure the tube is level.

5. Look straight down into the opening of the sighting tube to determine the presence or absence of ground cover components in the <u>center</u> of the opening.

6. Record the presence (hit) or absence (miss) of both herbaceous vegetation and shrubs, with 1 = hit and 0 = miss.

   a. Herbaceous vegetation: Record a hit if a grass or forb appears in the opening of the sighting tube. If not, record a miss. (If the herbaceous vegetation is growing under a shrub canopy, move aside the shrub limbs and foliage to sample the herbaceous cover.)

   b. Shrub: Record a hit if a shrub species appears in the pinpoint opening of the sighting tube. If not, record a miss.

7. Use the overstory sighting tube to sample tree canopy cover. Stand at the point where herbaceous vegetation and shrubs were sampled and look directly overhead. Place the sighting tube to one eye, and hold it perpendicular to the horizontal plane (i.e., vertically, not at an angle). Look at the point where the wires cross. (Be sure that the cross hairs are at the end <u>farthest from your eye</u>.)

8. Record a hit if there is canopy cover at the cross hairs; record a miss if there is none. (Canopy includes both foliage and limbs.)

9. Move to the next sample point and repeat this procedure.

APPENDIX B

CONSTRUCTION OF EQUIPMENT

MATERIALS

The materials required to construct one point frame and one overstory tube are listed in Table B1. The furring strip, brackets, screws, PVC pipe and cap, and tape can be purchased from a local hardware store. The rod level can be obtained from a forestry supply retailer, and the guitar string is available at music stores. The cost of all items is less than $30 (1994 prices). Canisters from 35-mm film can be acquired from photographers.

POINT SAMPLING FRAME

Instructions for constructing the sampling frame are provided below.

1. Cut a 1- by 2-in. furring strip into a 1-ft length and a 4-ft length.
2. Position the strips to form an "L" shape and attach with 3-in. flat metal corner brackets mounted on each side (Fig. B1). Holes should be drilled for the insertion of wood screws, as drilling prevents boards from splitting.

Table B1. Materials required for point sampling equipment

Item	Quantity
Frame	
1- × 2-in. furring strip	5 ft
3-in. flat corner brackets	2
8- × 5/8-in. wood screws	10
Heavy-duty rod level	1
Black plastic film canister	1
Tape	2 ft
Overstory Tube	
3/4-in.-diam PVC pipe	5 in.
3/4-in.-diam PVC pipe cap	1
0.008-in. light-gauge guitar string	1

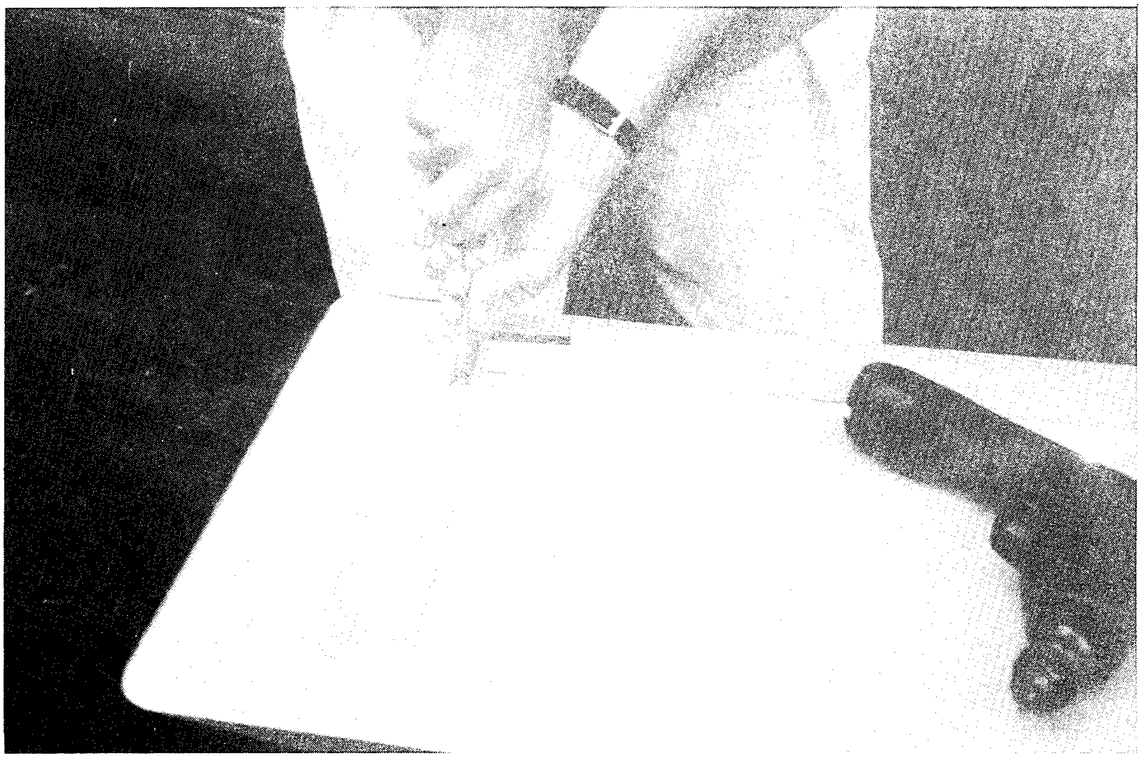


Figure B1. The two strips are attached with corner brackets to form an "L-shaped" frame

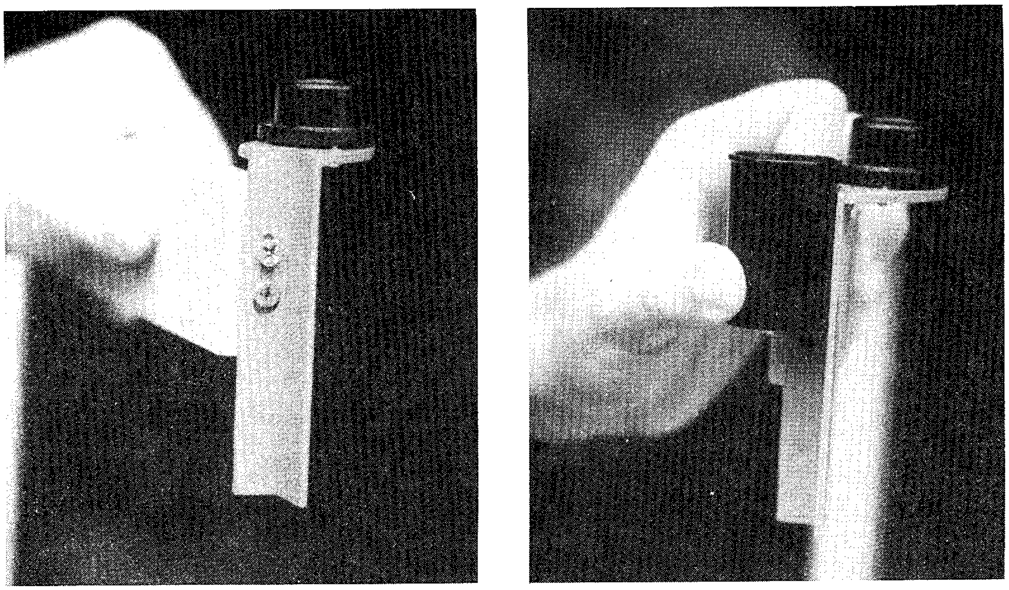
3. Mount the rod level vertically at the end of the short horizontal strip (Fig. B2a). Two screws will be sufficient to hold it in place and ensure alignment.

4. Punch a tiny hole in the bottom of a black 35-mm film canister. Mount the canister (without the canister top) next to the rod level; be sure the bottom is toward the ground (Fig. B2b). Tape the canister securely onto the frame, being careful not to bend the canister into an oval shape while wrapping (Fig. B3).

OVERSTORY SAMPLING TUBE

The equipment and materials needed to construct the overstory sampling tube are listed in Table B1. The following instructions are provided for construction of the tube:

1. Cut a 5-in. length of 3/4-in.-diam PVC pipe. (Use a hacksaw or PVC cutters.)



a b

Figure B2. The rod level (a) and the sighting tube (b) are mounted at the end of the short strip

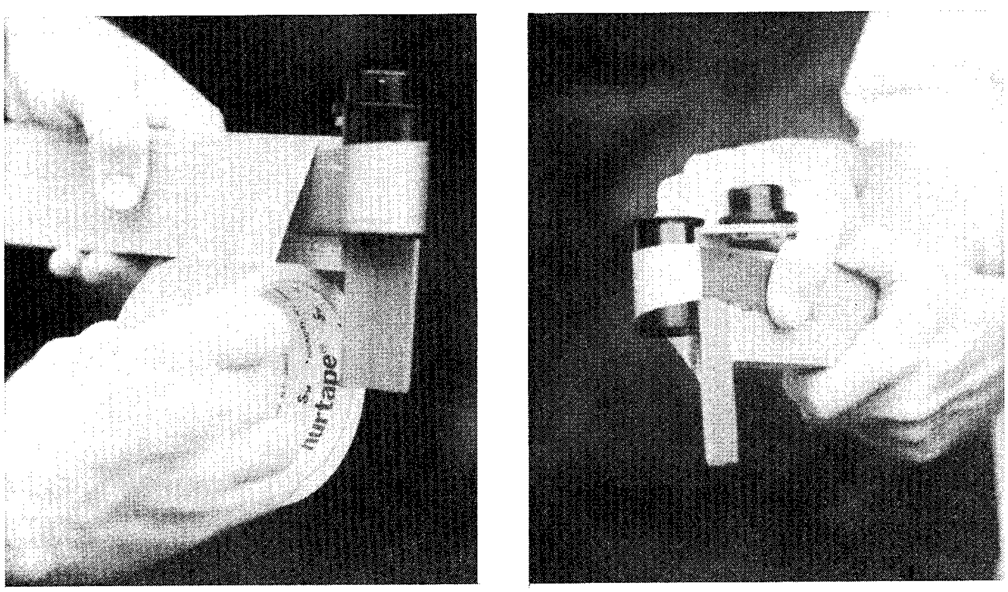


Figure B3. The canister is taped securely to the frame

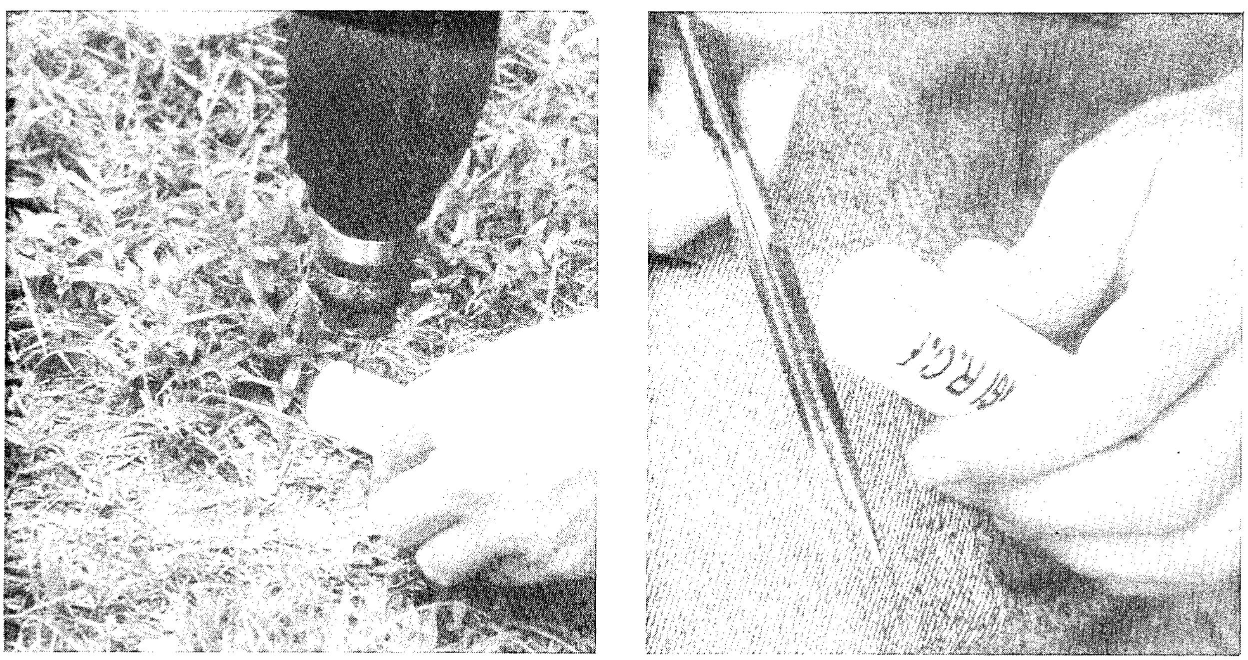
2. Drill 4 cross hair holes 0.5 in. from the end of the tube (1 hole on each side) (Fig. B4a). Use the smallest available drill bit.

3. Thread an 0.008-in., light-gauge guitar string through the drilled holes to construct cross hairs. Pull the string tight, tie knots at the first and last holes threaded, and clip with scissors (Fig. B4b).

4. Wrap tape around the last inch of the tube to cover any exposed wire (Fig. B5).

5. Using the same drill bit, drill a hole through the center of a 3/4-in.-diameter PVC pipe cap (Fig. B6a), and twist the cap onto the end of the tube opposite the cross hairs (Fig. B6b).

6. The finished sighting tube is shown in Figure B7.



a b

Figure B4. Holes are drilled at one end of the PVC pipe (a), and the string is threaded through the holes to construct cross hairs (b)

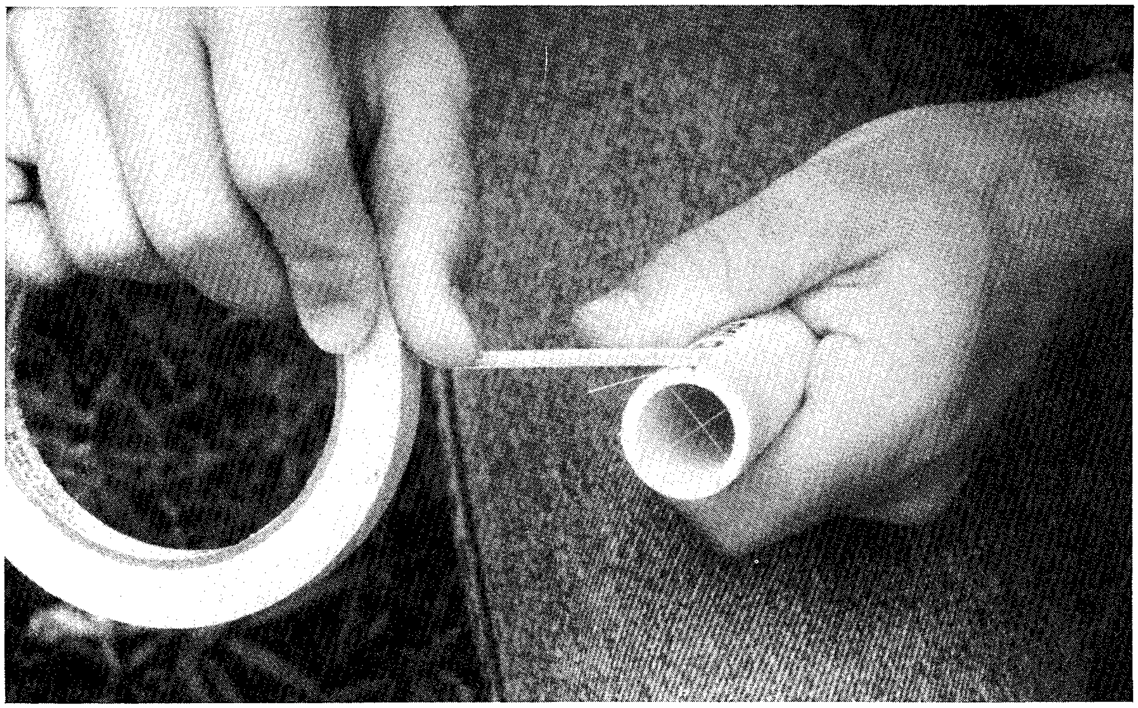
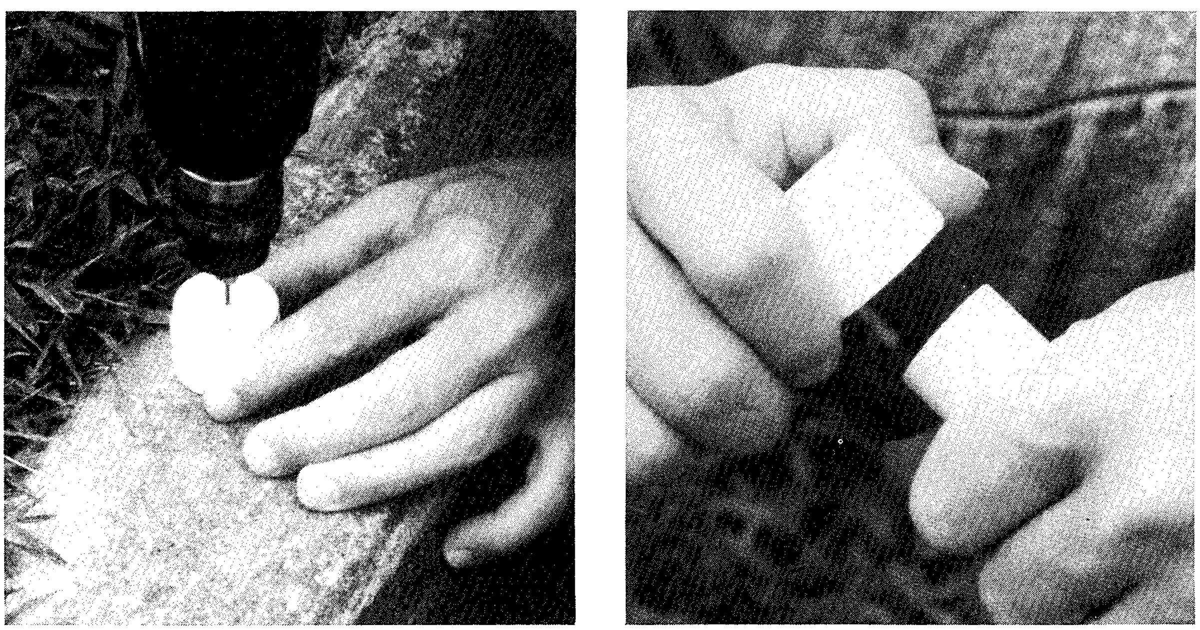


Figure B5. Tape is wrapped around the end of the PVC pipe containing the cross hairs



a b

Figure B6. A hole is drilled in the PVC pipe cap (a), which is placed on the end of the pipe opposite the cross hairs (b)

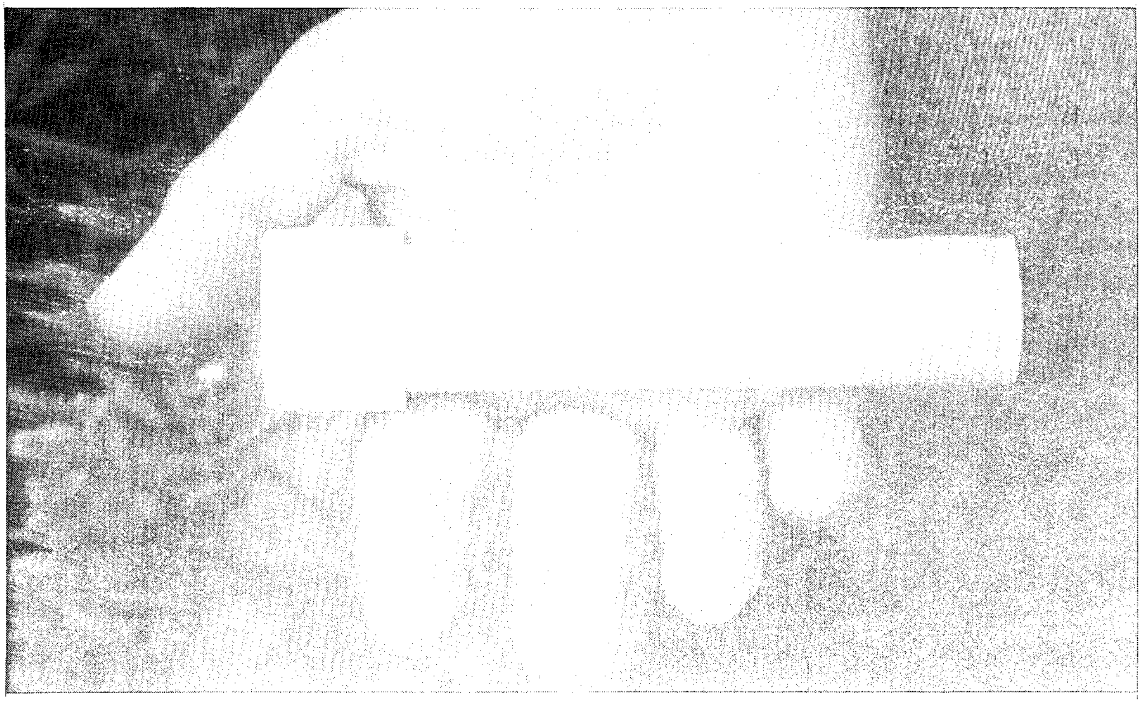


Figure B7. External view of the overstory sighting tube

APPENDIX C

POINT SAMPLING DATA SHEET

POINT SAMPLING

AGENCY/OWNER:__________ PROPERTY:____________________________ DATE:__________

OBSERVER:________________ COUNTY:________________ ACREAGE:_____ STAND NO._____

VEGETATION TYPE:__________________________ COMPARTMENT/UNIT:____PAGE____of____

Station	Point Number										Hits/Station			$\sum$ Points w/Hits
	1	2	3	4	5	6	7	8	9	10	$\sum$H	$\sum$S	$\sum$T	

	$\sum$H	$\sum$S	$\sum$T	
Total Hits				
% Cover				
Total % Cover				

$$\bar{X}\ \%\ \text{Cover} = \frac{\text{Total No. Hits}}{\text{Total Points Sampled}} \times 100$$

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	July 1995	Final report

4. TITLE AND SUBTITLE
Point Sampling: Section 6.2.1,
U.S. Army Corps of Engineers Wildlife Resources Management Manual

5. FUNDING NUMBERS
EIRP WU 32420

6. AUTHOR(S)
Wilma A. Mitchell, H. Glenn Hughes

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road, Vicksburg, MS 39180-6199;
Pennsylvania State University-DuBois,
DuBois, PA 15801

8. PERFORMING ORGANIZATION REPORT NUMBER
Technical Report
EL-95-25

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers
Washington, DC 20314-1000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

A report on point sampling techniques is provided as Section 6.2.1 of the U.S. Army Corps of Engineers Wildlife Resources Management Manual. These techniques may be used by the Corps District or project biologist to rapidly estimate percentage ground cover of vegetation on project lands. Topics covered include guidelines for technique selection and study design, preparation for sampling, procedures for data collection, recording, and data analysis.

The techniques described in this report utilize single points, rather than groups of points, at each sampling stop. Point sampling is conducted by one observer, who locates sample points at given intervals along a transect and records the presence or absence of herbaceous, shrub, and tree canopy cover at each point. Point sampling can be applied to a wide variety of vegetation types but gives the most reliable results in open and semi-open habitats, such as

(Continued)

14. SUBJECT TERMS	15. NUMBER OF PAGES
See reverse.	36
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED		

13. (Concluded).

grasslands, savannas, old fields, and open forests. It is especially useful for sampling extensive areas when manpower and/or resources are limited, as one person can conduct point sampling with minimal equipment.

Detailed instructions are given for recording and analyzing data; these are accompanied by numerical examples that illustrate each step of recording and data analysis. A reproducible form is also provided for recording and calculating point sampling data.

14. (Concluded).

Canopy cover
Cover estimation
Ground cover
Point frame
Point sampling
Rapid sampling technique
Shrub cover
Step point
Vegetation sampling